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SEWERAGE IN NEW HAVEN.

REPORT OF E. S. CHESBROUGH, ENGINEER-IN-CHIEF,

[*Concluded.*]

Size of Sewers.—For a short street not exceeding three or four hundred feet in length a twelve inch pipe sewer is recommended.

For an area not exceeding eight acres an eighteen inch pipe sewer is recommended.

For an area over eight acres and not exceeding twenty acres a two foot sewer.

For an area over twenty acres and not exceeding forty acres, with inclination of one in five hundred, a thirty inch sewer. This same size will answer for drainage of forty-five acres with an inclination of one in four hundred and for fifty acres with an inclination of one in three hundred; three foot sewers for an area not exceeding 75 acres with an inclination of 1 in 600; for area not exceeding 80 acres an inclination of 1 in 500; for an area not exceeding 85 acres an inclination of 1 in 400; for an area not exceeding 90 acres an inclination of 1 in 300; for an area not exceeding 100 acres an inclination of 1 in 200.

Forty-two inch sewers will drain forty acres in addition to the areas above given with the same inclination.

Four foot sewers will drain one hundred acres in addition to the areas given above for three foot sewers with the same inclination.

Four and a half foot sewers for an area of 300 acres with an inclination of 1 in 600; for an area of 325 acres with an inclination of 1 in 500; for an area of 350 acres with an inclination of 1 in 400; and for an area of 375 acres with an inclination of 1 in 300.

Five foot sewers are recommended for an area of 375 acres with an inclination of 1 in 1000; for an area of 400 acres with an inclination of 1 in 800; for an area of 450 acres with an inclination of 1 in 600; for an area of 475 acres with an inclination of 1 in 500; for an area of 500 acres with an inclination of 1 in 400; for an area of 550 acres with an inclination of 1 in 300.

The specifications for building the sewers and their appurtenances, which were prepared in July, 1871, before the letting of any of the contracts, give the detailed description of their construction of the materials to be used therein. These specifications conform in all their main requirements to the practice in the principal American cities, but may have to be modified slightly to adopt them here. The sewers if built in conformity to them will be durable and substantial, and should not require any outlay for repairs in many years.

The bottom of the main sewers at the outlets is to be about one foot above low tide, the East street outlet having been constructed a little higher. Experience shows that sewers which are not unnecessarily large, and have proper inclination, very rarely have deposits in them, where the tide ebbs and flows through them. Generally the bottom of the pipe sewers should be ten feet below the grade of the street and the bottom of the brick sewers should be about two feet lower, or twelve feet below the grade of the street. It may be proper to state that the outlet sewers so located would be empty twice in 24 hours, and that the scouring effect of this discharge would have the tendency to prevent the deposit of sediment in the sewers.

The marginal intercepting sewers near West river and near Mill river above Laurel street cannot be satisfactorily located until the streets or avenues are laid out in which they are to be built.

The intercepting sewers, when they are extended to near the northern limits of the City, could easily be flushed and cleansed.

The Laurel street sewer between East street and Mill river, is intended to discharge surplus water into the river during very heavy rains, when the depth of the current in the East street sewer exceeds 17 inches. At all other times the sewage of this entire district will be carried to the main channel of the harbor. During very heavy rains the discharge over the weir will be so diluted as to be very inoffensive. It is proposed to construct several such waste weirs and overfall sewers on the line of the West river intercepting sewer whenever that work can be carried out.

In the construction of the sewers the greatest care should be taken to make tight joints so that the sewage may not leak out into the porous soil. At the same time it is very desirable to drain the sub-soil, when it is wet, through the sewers. This is always slowly but surely accomplished when the sewers are built of brick, because this material is sure to be somewhat porous yet not enough so to let out offensive matter when the sewers are filled or nearly so by excessive discharges into them.

Ventilation.— The proper ventilation of sewers has caused much discussion. It is impossible to prevent some bad air from collecting in sewers when offensive substances are discharged into them, but experience shows that when the sewers are well planned and constructed, the general supply of water to the town sufficient, and the house drains properly trapped and otherwise arranged, there is seldom any serious difficulty.

Permits to lay House Drains.—Although house drains are almost universally laid from their connections with the main sewers, at the expense of the owners of the premises

to be drained, this should always be done under the permission and general supervision of the Board in charge of the sewers, and under the immediate inspection of an officer appointed by such Board; and by a licensed drain-layer, giving sufficient bonds to secure the faithful performance of his work. These restrictions are necessary to prevent not only improperly arranged house drains but unfaithful execution of the work, a source frequently of great annoyance to housekeepers. Owing to ignorance and carelessness, improper substances, such as cloths, broken crockery, etc., are emptied into house drains, causing stoppages and much trouble; but regular drain layers can usually remove them in a short time.

Some objections considered.—An answer will now be made to an important question which may arise in the minds of some as to what would be the use of sewers in case future invention and discovery should enable the inhabitants of cities to make profitable, without discharging them into the sewers, the substances now wasted? Even then the sewers would be a necessity to avoid flooding the streets in very wet weather, to drain the sub-soil in many parts of the city, and to remove from houses the large amount of comparatively pure water that would be discharged from baths, laundries, and kitchens. Before such a system, so desirable in itself, can be expected to be established, if in this century, provision of some kind must be made for the removal from houses and other buildings of the various discharges which are the inevitable accompaniments of large cities, and must be got rid of in some way, or they will produce pestilence.

With all the objections to modern sewerage systems, its opponents are not able to devise a cheaper mode of removing the discharges from houses and manufactories of large cities, than by means of sewers in connection with a good supply of water, nor are they able to show better sanitary results.

Another important question has already been asked. It is, will not the offensive constituents of the sewage, immediately after reaching the outlets, be precipitated into the channel, and thus eventually obstruct it to the great injury of commerce; or, if not thus precipitated, will they not by the action of flood tides be gradually spread out over the flats, and become prejudicial to the health of the City? That to some extent the channels and flats may be injuriously affected, if New Haven should increase in population as rapidly as heretofore, can be proved from experience elsewhere. The same experience, however, shows that the effects thus produced are far less objectionable, or less difficult to remove, than those which must result from attempting to do without sewers. If some years hence it should be found necessary to construct receiving basins near the outlet of the New Haven sewers, so as to discharge the sewers into the channel just before and during such portions of the ebb tide as would prevent its return in an offensive form, then such basins could be constructed and maintained as advantageously as in other cities.

The practical inquiry in New Haven is not whether to have substances prejudicial to health produced in the city or not. This has been settled by the building of the City, and by the domestic and business habits and necessities of the people. The real question is, shall these objectionable substances remain in part near the dwellings of the inhabitants, or be removed to the greatest practicable distance? The assertion may be made with much confidence that no important city having a well arranged system of modern sewers would return to the old order of things, even if fully reimbursed for the cost of the sewers. On the contrary, the well nigh universal desire in such cities is to extend the benefits of sewerage faster than their means appear to justify. The safest guide in such matters is the largest experience.

Pure, or comparatively pure water, whether salt or fresh, in tidal or other streams, will render innocuous an appreciable percentage of sewage or other organic impurities. Were this not so, many of the most populous cities and districts of the world would have long since ceased to be habitable. This purifying quality of water may be safely relied upon, to its usual extent, in New Haven. Before that extent shall have been dangerously exceeded, it may be that some, if not most of the offensive substances now emptied into sewers, will be utilized; for nearly the whole civilized world is not only interested in this problem, but directly or indirectly engaged in seeking its solution. Should the problem be solved, then nothing will have been thrown away on imaginary necessities, and nothing done in carrying out the plan now adopted that would not be worth its full cost to the City.

I feel under peculiar obligations to acknowledge the aid of Moses Lane, Esq., whose experience while in charge of the water and sewerage works of Brooklyn were of great value. C. E. Fowler, Esq., City Surveyor, furnished a large part of the information upon which the plans have been based. He has had the responsibility of carrying them out thus far, and has done it in a very satisfactory manner. I also take pleasure in acknowledging the valuable services of Messrs. I. C. Chesbrough, W. S. McHarg, and A. B. Hill, on the surveys, estimates, and plans.

[To the report is appended eight lithograph plates. Plate No. 1, is a general plan of the sewerage system, showing the location and size of every pipe proposed. Plate 2 shows two out of the three main outlets of the system into the Harbor; the one a section of a 5 ft. × 5 ft. outlet, with flat sides and invert and semi-circular crown, the other a circle 5 ft. dia. Plate 3 shows comparative sections of circular brick sewers of 48 in., 54 in., 60 in., 66 in., and 72 in. dia. Plate 4 shows comparative sections of circular and egg-shaped sewers of equal areas, the circular sewers being 24 in., 30 in., 36 in., and 42 in. dia., and the egg-shaped sewers being of the same form and construction as Fig. 10 in "Examples of Sewers," No. 4 of the ENGINEER, ARCHITECT AND SURVEYOR. Plate 5 shows plans, and sections of two manholes, one of circular section for a brick sewer, the other of oval form (same as Fig. 11 in "Example of Sewers," above referred to) for a pipe sewer. Plate 6 shows a plan and section of a catch basin 4 ft. dia. and 8 ft. deep from top of curb stone. Plate 7 shows a plan of a sewer junction, and a plan of the Laurel Street overflow, referred to in the latter part of the report. Plate 8 shows sections of a trapped brick basin, and of one single and one double pipe-trap.]

RECLAMATION OF LAND IN ITALY.

DRAINAGE OF LAKE FUCINO.

One of our Engineering contemporaries recently favored its readers with remarks on "ladies' engineering," *apropos* of a copy of Harper's Bazaar left on the editorial table. We can "go one better" than that, for there are no less than three lady subscribers on our list, who take a lively interest in engineering matters, and one of whom has kindly furnished the materials from which much of this article is compiled.

Lake Fucino was until recently, a large body of water lying in the Appenines of Abruzzi, completely surrounded by a chain of calcareous mountains, the lowest of them

rising 1000 feet above the lake, and forming a watershed of about 50 miles in circumference; the average depth of the lake, however, was not more than 12 feet.

Long before the Christian Era the inhabitants of its fertile borders were much harrassed by the constant and capricious fluctuations in its surface, at one time inundating their lands and gardens. at another receding too far away therefrom to render any system of irrigation of permanent value. Though receiving many mountain streams into its basin there was no visible outlet, the excess of water supply finding its way out through fissures which are generally to be found in calcareous formation. At length in the reign of the Emperor Claudius an attempt was made to drain the lake by tunnelling through Monte Salviano, the western boundary, and forming thus an *emissarium* from the lake to the river Liris which flowed at the foot of the western slope of the mountain, about three miles from the lake.

This tunnel is constructed for nearly one half its length on a curve in plan, and was excavated precisely as in modern times, from vertical shafts sunk at equal distances apart on the line of the tunnel.

It occupied 10 years in construction, and was completed A. D. 52, no less than 30,000 men having been constantly employed upon it. The opening ceremonies were of a very imposing character, but like our deepened Illinois and Michigan canal after the "Ogden ditch" was opened, it "didn't work worth a cent," in draining the lake. The masonry at the two ends was very well constructed, but owing to inefficient supervision the workmen "scamped the job" in the central portions, and it was also discovered that the upper end of the tunnel was too high to drain the lower portion of the lake. The flow from it was thus intermittent, and though various attempts were made to improve it, from time to time, nothing was permanently successful until the great reclamation lately completed.

Though the lake occasionally fell, its tendency on the whole was to rise, and in 1816 it had risen eleven metres in thirty years. At length, in 1852, a company was formed to effect the drainage at their own risk, with a concession of all the land actually recovered from the lake. Difficulties, however, arose, and the scheme would have fallen to the ground like its predecessors but for Prince Torlonia. He already held one half the shares, and he boldly took up the other half, thus becoming in person the company. He immediately put the work into the hands of Montricher, the engineer of the Durance canal, who submitted two plans to him. One was the restoration, rectification and enlargement of the Claudian emissary, by which he guaranteed to drain the lake completely, but not to protect the lower parts of the basin against innundations in times of excessive rains. The other was to pierce a new tunnel quite independent of the old Roman one, of a much greater bore, and constructed to last for all time and carry off any amount of flood. With equal spirit and wisdom, Prince Torlonia chose the latter, and for eight years perseveringly pushed on the work in the teeth of endless difficulties of one kind and another. At a critical period Montricher died, and at one time success looked so doubtful that it was a saying in Italy that "if Torlonia did not drain Fucino, Fucino would certainly drain Torlonia." At length, under M. Bermont, the successor of Montricher, the passage of the water was effected, and the peasants of Avezzano, who were, and no wonder, sceptical as to the result, had to admit that "this time Fucino was really on the move." Since then the work has proceeded steadily, and Fucino has been gradually changed into a broad, fertile plain.

Thus, the lake, which was formerly 35 miles in circumferance, and within one mile of the town of Avezzano, is now barely three miles in circumference, and fully an hour's drive from Avezzano. The drainage works consisted of the tunnel under the mountain, a large basin at the upper end of the tunnel, and a canal extending from the basin through the former bed of the lake. The canal is connected with the basin by three sluices, and the basin with the tunnel by a fourth sluice.

The land reclaimed amounts to some 45,000 acres, of which 6,000 acres belongs to individuals, being land which for years past was either totally submerged, or else flooded three years out of every four. Though Prince Torlonia had a perfect right to a proportionate amount of the increased value of this 6,000 acres which is now worth four times as much as formerly, he has most generously waived that right in the interests of the neighborhood.

Another great benefit accruing from this reclamation, is the extinction of brigandage in the surrounding mountain passes and neighboring roads. The frequent fluctuations of the lake threw numbers of the peasantry out of employment, and of necessity they became "road agents."

The commencement of these great works however, gave them constant employment, and now they have settled down again on their former possessions, which are permanently secure and safe.

COAST AND HARBOR SURVEYING.

[CONCLUDED.]

We now come to measurements, such as have been described, which led to and included the determination of the metre, the unit of length employed by the Coast survey since the time of its organization, and lately, with the system of which it is the base, legalized for general purposes by Congress.

A map may be either with or without latitude, longitude, and scale; that is, without designated relation to the earth's surface—a mere fragment, which, for aught that it declares on its face, might equally well belong anywhere else. But no matter what, great or small, the area of the portion of the earth's surface delineated, the Coast Survey and other geodetic works gives the map in its true position and magnitude with reference to the whole earth, the drawn parallels and meridians corresponding to the parallels and meridians of that portion of the earth's surface; for the operations described must, it is perceived, give the elements for the projection of maps for every degree of latitude, and compel the points determined to fall rightly in the minutes of latitude and longitude as represented on the projection. Of course any length, as the foot, may be adopted arbitrarily and used as the unit of length; but the metre, used by some geodetic works, is, from the fact of its being a fractional part of the polar circumference of the very globe that we inhabit, the most desirable of any known.

Measurements of arcs of the meridian, with more or

less rude approximation, date back to a very ancient period. In modern times the first attempt worthy of notice was that of Fernel, a Frenchman, who measured the distance from Paris to Amiens, by noting the number of revolutions of one of his carriage wheels in journeying between the two places, assumed the two places to be under the same meridian, as they are nearly, and found their difference of latitude. The first person, however, to attempt a measurement in a really scientific way was Snell, a Hollander, who, with imperfect means, used essentially our methods. Norwood, an Englishman, made a measurement from London to York, but inadequately.

But from this time forth measurements of arc were to be made with scientific methods and means. Under the authority of the French Academy of Sciences, a measurement was taken, begun in 1675 by the Abbe Picard, in France, and was completed by the first Cassini in 1716.

An event had taken place, meanwhile, destined, by the stimulus it afforded, to lead to the final settlement of the question of the earth's figure. Newton's theory of gravitation, conceived in 1676, but not made public until 1686, and both his and Huygen's demonstrations from it, and from the action of the pendulum in different latitudes, then lately discovered, disagreed with the measurement of the arc in France. Accordingly, in 1734, the French Academy sent out two Commissions, of which one, under Bouguer and La Condamine, measured an arc under the equator in Peru, devoting to it ten years' labor, and the other, under Maupertuis, one in the high latitude of the Gulf of Bothnia. Both measurements sustained the theoretical deductions of Newton and Huygens. Maupertuis, and subsequently in a more thorough manner, beginning in 1739, Cassini de Thury and Lacaille, rectified Picard and Cassini's measurement in France, detecting grave errors in it, also reaching a result triumphantly sustaining Newton and Huygens.

Several minor operations, scientific and unscientific, in other countries, followed, including those of Mason and Dixon in this country, but all paled before those undertaken for the determination of the aforementioned unit of length, the base of the metric system.

A triangulation between London and Paris, begun in 1784, and completed before 1791, by the joint labors of the English and the French, preceeded it. Then, in 1792, Mechaim and Delambre, commissioned by the French Academy of Sciences, began the measurement of the arc between Dunkirk and Barcelona. The difficulties that they encountered and overcame are almost incredible, the French Revolution having broken out, and the whole country being in a ferment. Delambre was thwarted in every way, his signals suspected and destroyed as traitorous, he himself arrested, and twice, as he narrates, obliged to give to ignorant peasantry by the wayside a course of lectures on geodesy. Mechain, except at first, fared no better; at last, much worse; his labors, fatigues, privations, and anxieties contributing, with a fever, to terminate his career.

The work was subsequently continued along the eastern coast of Spain by Biot and Arago, to the Balearic Islands. It is in connection with this work that the most interesting episode recounted by Arago in his autobiography, is found, he being captured by a corsair, and during eleven months suffering many vicissitudes of fortune.

The metre, the French unit of length, was deduced, from the measurement of the arc from Dunkirk to the castle of Mont Jouy, near Barcelona; to obtain the oblateness of the earth, introducing the arc formerly measured in Peru, and the distance from the equator to the pole, as obtained, (mark that) was divided into ten million parts. I said, *as obtained*, because, after all, this metre of which we are speaking, is not, as having definite linear relation to a dimension of the earth, strictly correct. Let me explain through a quotation from Behm's Geographical Year Book, published in Gotha, Germany: "After Bessel had calculated, in 1837, from various measurements of degrees, the mean meridian degree to be 57011.453 toises, (the toise is about 6 feet); so that the meridian degree is 3¼ toises longer than had been assumed when the metre was fived, he declared the length of the meridian quadrant to be 10,000,565 metres, which gave for oblateness of the earth 1-299.1528. Doubtless, he says, every new measurement will give a new value, as the most reliable measurements show that the surface of the earth is irregularly curved. After this the Academy of Paris had to decide upon the metre question. Should the value of the metre be changed? Three members of the committee, Matthieu, Daussy, and Largeteau decided against such a change. Thus the metre remains, while its relation to the quadrant is changed, and thus the true and final metre is in fact an artificial measure deduced from the length of the toise."

In fact, as Bessel says, it is not based in nature, but an illusion. But yet, for all practical purposes, it is as good as if it were. The actual difference involved is only abont 1-500 of an inch in the length of the metre. And, moreover, it is imperishable unless all the records of it perish with many monuments of the art preservative of all arts, for the relation of its length to that of the pendulum which beats seconds at the Observatory at Paris was established.

The metre is an approximation to the truth. It is about 1-10,000,000 of the distance from the equator to the pole; that is 10,935,697 American yards; the distance being really, according to Bessel, 10,000,565 metres, or, 10,936,314 yards. A sheet of paper, therefore, measuring a metre in length could, using round numbers, include the earth from the equator to the pole, on the scale of 1-10,000,000—or half a metre in length, on the scale of 1-20,000,000. Coming down to ordinary scales (for scales used are generally less, or very much greater than these), we have the scale of 1-10,000 that of one of the maps which I shall presently show you (the ordinary scale of the Coast Survey, upon which a metre on the map is 10,000 metres on the ground). There is the scale of 1-5,000, upon which a metre on the map is 5,000 metres on the ground (a scale often used by the Coast Survey for places of much detail, the one to which the survey of the upper part of this Harbor, where the waters are contracted, was enlarged); the scale of 1-2,500, used in special surveys of limited area, where, for instance, questions arise of the deposit of detritus; or even larger scales, for representing fortifications, the wharf-face, or the interior of cities.

Topography is based upon triangulation. In it, as

in triangulation so-called, excepting primary, the work is carried from exterior to interior. A triangulation consisting of sides less in length than those of the tertiary, and derived immediately from that triangulation, is made with the plane-table.

The plane-table, the instrument which you see before you, is, in its improved form, and with the improved skill in its management and adaptation to the ground, the best instrument for topography. Its superiority consists in the facility which it affords to the operator, to take, and to plot at once with the greatest rapidity, angles ranging from those to the most important, to those to the least important objects; thus combining the office and the field.

With the plane-table, points are not, as in triangulation proper, determined solely for the purpose of determining others from them, to form a mesh of triangles related solely to themselves; to accomplish which signal-poles are erected, spires and towers brought into requisition, and heliotropes made to flash from mountain heights. Points given by the triangulation are plotted on a projection representing minutes of latitude and longitude, and from these are determined points closer to each other. The two sets are the basis upon which other points, consisting of an immense number of natural and artificial objects, depend.

When the plane-table (the sheet extended upon it representing a definite portion of the earth's surface) is "in position," as it is called, the drawn lines of parallel and meridian of the sheet correspond in direction with those of the earth; a point that can be found and plotted on it represents the position of the instrument; and every visible station of the triangulation, if looked at through the telescope of this instrument, which is called an alidade, will if the edge of the ruler pass through that station, as laid down on that paper, and the point of the instrument's position, as laid down on the paper, appear upon its crosswires.

With the tertiary triangulation, is connected the secondary, and, in turn, the primary, going back to a base upon which the primary depends; so that when the plane-table is in position, nothing but the curvature of the erth, and, that aside, the limit to range of vision, prevents its proving its position by right of *lineal descent*. From the base, from the largest triangle of the primary triangulation, to the smallest one that fixes the position of a buoy, a spindle, a fence-corner, or a barn, the whole work of the Coast Survey is in perfect harmony.

Of course, from the indefinite multiplication of points, any broken line or any curve may be found and mapped. But beyond a certain degree, the multiplication of points by plane-table triangulation would embarrass and delay the operator. He therefore makes use of certain appliances which supplement the function of the plane-table. By means of an instrument, called the telemeter, which has several forms, he determines the distances of objects at a single sight; by means of the chain and steel tape, he meas ures minute details; and he plots both kinds of measurement by the angles given by the plane-table.

Every map is, in fact, a miniature, and like other miniatures should take no cognizance of unessentials. The triangulation, recognizing curvature and pervading every topographical sheet, keeps every series of maps, however large, exactly in place. The survey of a single State, if conducted without reference to the sphericity of the earth, would be in error by many miles.

Hydrography, in its turn, is based upon topography. In its turn, it is pervaded by the same system which I have sketched.

The problem of hydrography, as I often heard a distinguished hydrographer say, is a very simple one. It consists in taking a depth correctly, in determining the position of the sounding, and in reducing it to the plane of reference. These conditions, simple as they are, are not always fulfilled so exactly, in certain depths and on certain bottom, as to produce lines of soundings, made under the heave of the sea, which shall cross each other, showing a difference of only one or two-tenths of a foot.

The reduction of a single sounding, or of a line of soundings, to a plane of reference is easy. A tide-gauge being read throughout a lunation, any plane between the highest and lowest point of the rise and fall of the tide is obtained—say the plane of mean high water, of mean low water, of the highest high water, of the lowest low water. The Coast Survey uses the plane of mean low water. Now, if on the same gauge the rise and fall of the tide, and the time also, are noted while soundings are being made with noted time, the height of the water at any given moment above or below the mean low-water line of the gauge represents the amount to be subtracted from, or added to, any sounding made at the same moment.

In water as shallow as between two and three fathoms, soundings should be made with a pole; and the shallower the water, the more accurately the soundings can and ought to be taken. In these are used the fathom, common to all nations, and supposed to be derived from the length obtained from the outstretched arms.

To fix the sounding in its true position is the most difficult of the three operations mentioned. This is done either by taking at a signal simultaneous angles to a boat, from the ends of a base on shore, and sometimes, in ocean-island work, from a base on the water, determined by sound; or, by taking angles with the sextant from the boat to stations on shore; or by finding on the water, the intersection of ranges of shore signals.

When the position of a boat or vessel is determined by one or other of these methods, it may then fix the position of a single sounding, or else, running thence, sounding at equal intervals of time, on a given line, can bring up at a point determined by ranges, by the sextant, or by observation from a base line on the land or on the water. Upon the assumption that the boat or vessel has passed over equal spaces in equal times, the soundings are plotted from one point to the other by subdividing the line by the number of soundings along it. The degree to which this procedure can be carried depends upon the scale of the proposed map, the greater or less opportunity for cutting the given line by ranges, as the boat or vessel passes these, thus securing new points of departure; and the greater or less prevalence of currents not uniformly accelerating or retarding the speed of the boat or vessel.

On the maps you will see that minute contours of the shore are recognizable, and that the character of the land and of the bottom, with the depth of water,

appear. From them can be judged the relative stability of the shores and the bottom, the volume of water at any point in the Harbor can be found, and with current observations above, the volume of water pouring into the Harbor from the land can be ascertained. From these data, experts in physical hydrography can reach just conclusions as to what measures to adopt, acting in conformity with nature's laws, to make an improvement in these waters.

Questions are involved in this investigation which can be discussed upon no other basis than a good map. The duties of the Harbor Commissioners, setting out with a physical examination of the rivers' mouths and the Harbor, from the maps furnished by the late survey, and from observations of the sets of currents, etc., must, first of all, establish some theory for improvement of the Harbor, based upon data which, with great painstaking, have been acquired in similar cases both at home and abroad, and carefully apply the conclusion at which they arrive to the case in hand. At every turn they will require a map to aid them in the consideration of the effect of a given change, when the time shall have arrived for them to decide questions upon which momentous interests depend.

If I understand aright the creation of the Board of Harbor Commissioners, and its investiture with certain powers, it is the recognition and putting into effect of the view, entertained by all maritime cities, at an advanced stage of their growth, when they realize that their commercial interests are large and probably will become larger, that their water ways are their most important highways, and just as a city has a right, in the public interests, to restrain individuals from obstructing or tending to obstruct the land highways, and is itself bound in duty to seek to improve them, so it has an equal right to exercise jurisdiction, and a duty to perform, in regard to the others. In no other manner could the important duties devolving upon the gentlemen forming the Harbor Commissioners be performed than by the constant use of a good map on a *large* scale.

The question, for example, of pushing out a jetty, whether intended to effect a favorable change in an adjacent channel, by causing a deposition elsewhere of material carried in suspension in the current, or as an effort of private enterprise, in which ulterior consequences are not considered; or the question of the removal of one existing, must be the subject of deep consideration, if both public and private interests are not to be imperilled but conserved. Unless such constructions in a place subjected to experiment be represented on a large scale, in due relations to all others within a long range, interference with the status of the water-face of the Harbor would be attended with risk, for only upon a map on a very large scale can be observed small relative changes in areas subjected to experiment by an initiatory step.

Such a map, as applied to a city, as a whole, especially a rapidly growing city, enables the authorities to lay out to advantage the parts which are pushing beyond those first laid out, which are necessarily somewhat fixed in their character. There is not a city in the world but would have been much improved upon, if at an early stage of its growth it had had a map on a large scale by which to guide its extensions. Not, perhaps, improved according to the ideas of Ruskin, but certainly to those of most people, who believe that cities are built primarily for comfort, not for the picturesque. As no early settlement can infallibly predict its growth to importance, it would obviously be preposterous for every one to regard such growth as a foregone conclusion and act upon it. But on the other hand, when a place has reached such importance as to leave no longer in doubt that it will attain much greater, it is equally preposterous not to look to its extension upon some well matured plan.

Such a map relates not only to the horizontal projection of the ground, but to its vertical projection also; not only to the laying out, with discretion, of streets and squares and suburban cemeteries and parks, but to the establishment of lines of drainage. The drainage of a city should be conducted with reference to its whole area regarded as a water-shed. It is only from maps on a large scale that we can study large areas and conduct drainage to the best advantage. I speak now of drainage as belonging to the present surface, whether natural or artificial, or mixed, as, in a word, belonging to the present "lay of the land." But there is another drainage, which is said to proceed by infiltration of water down to the natural slopes, although they may long since have disappeared to the eye in consequence of fillings. This is said to settle sometimes below the soil, and finding slow escape, to give off exhalation through the surface, infecting the air of the surrounding place. To keep the record, in sanitary interests, of these original water-sheds is, perforce, part of the province of a good map on a large scale, that their site may be known, that dammed up pools may be tapped, and the malarious influence removed.

In the case of devastating fire such a map would form the basis for the restoration of ancient landmarks. No question concerning the former physical condition of the city could arise which such map could not answer.

No question regarding the *present* physical condition could arise which such map could not answer. Such a map is a city *in petto*. From a few points of view every part of it can be commanded, and an improvement better devised in the office than on the ground, where the vision, being limited in range, the relation of things beyond a very small area is not perceived, and, at best, is liable to error. Does the engineer wish to know what filling is required? He has but to consult the map. Does he wish to know what cutting? Again he has but to consult the map. To lay out anything, to do anything, to advantage, he must consult the map. Else, piecemeal, he must make plots for himself, and use them disconnected, by themselves, in no relation as must be desirable, to a greater design. It is as though, comparing small things to great, a geographer laying down his own country minutely, should leave out the rest of the world.

When the bicarbonate of soda, or of potash, in a dry pulverized state or in a watery solution, is heated in a closed space, part of the carbonic acid is given off and condensed in the now heated portion of that space, so that, at a temperature of from 636° to 843° Far., the liquid carbonic acid distilled from those salts has a tension of from 50 to 60 atmospheres. This "carboleum" it is proposed to use in developing gas to form a new motive power in many cases to supersede steam.

LAW AND LEGISLATION.

An abstract of decisions of the Supreme Court of the United States and of the courts of the various States in the Union upon questions relating to boundaries, surveys, etc.

166. A grantor made a deed of bargain and sale of land, describing it by metes and bounds, and as bounded on one side by a street, and also as being "the same that was set off to W." The land set off to W did not extend to the sheet, and the grantor was not seized of any land besides that which had been set off. Held, that the land which the deed purported to convey was truly described by the metes and bounds referred to, and that this description was not controlled by the subsequent reference to the land set oft to W. Dana v. Middlesex Bank, 10 Met. (Mass), 250.

167. The lines marked on the ground constitute the actual survey, and control the return of the surveyor, even where a natural or other fixed boundary is called for by the survey, though the space between the two is but twelve perches in breadth. Walker v. Smith, 2 Barr (Pa.), 43. Had v. Tanner, 4 Barr, 244.

168. Where course and distance only are given in a deed, parol evidence is not admissible to show a different line by marked trees, to be the true one. Wyme v. Alexander, 7 Iredell (N. C.), 237.

169. Where a deed calls for a line, by course and distance, from one point to another, the line must be run straight from one point to the other, and cannot be varied by marked trees near a straight line, though the trees were marked by the parties as showing the line at the time the deed was made. *Ibid.*

170. Where, in describing a boundary line, another known line is called for, and the distance gives out before reaching the line called for, the distance is to be disregarded. Gilchrist v. McLaughlin, 7 Iredell (N.C.), 310.

171. A grant called for a line from a certain point, "thence N. 87° W., 179 poles to a hickory, thence the courses of the swamp to the beginning." The distance fell short of the swamp nine chains and fifty links, and no hickory course could be found, and there was no proof of its having been there. Held, that the line should be extended on the course to the swamp. McPhaul v. Gilchrist, 7 Iredell (N. C.), 169.

172. In locating lands, marks made by the surveyor, as well ascertained natural or artificial boundaries, are to prevail over course and distance. And it was so held, although the boundaries included 136,000 acres, instead of 14,900, the number called for by the deed. Sturgeon v. Floyd, 3 Rich. (S. C.), 80.

173. Special or locative calls must control those which are merely directory and general, and no accumulation of such general calls will control locative calls, but the plat and certificate of survey accompanying a grant is competent evidence, and may, in connection with the directory calls, control the locative calls. Bell v. Hickman, 6 Humph. (Tenn.), 398.

174. The great principle which runs through all the rules of location is that where you cannot give effect to every part of the description, that which is more fixed and certain, shall prevail over that which is less so. Johnson v. McMillan, 1 Strobhart (S. C.), 143.

175. The rule, that natural or artificial boundaries will control distances or courses, authorizes no other departure from the course and distance than such as is necessary to effectuate the apparent intent of the grantor. *Ibid.*

176. Distances may be increased, and sometimes courses departed from, in order to preserve the boundary; but the rule authorizes no other departure from the former than such as is necessary to preserve the latter. *Ibid.*

177. If no principle of location be violated by closing from either of two points, that may be closed from, which will be more against the grantor, and include the greater quantity of land. *Ibid.*

178. Where a boundary of land, conveyed by patent from the United States, is described by course and distance, terminating at a post, and neither any marks indicating such boundary, nor any post indicating its termination are to be found on the land, parol evidence that a line was found marked upon the trees upon the land, but variant from the call of the patent, and not indicated by the monument called for in the patent, was the actual line surveyed, run and marked as such boundary by the Government Surveyor, will not be admitted, to alter or vary the boundary, as described by course and distance in the patent. Bruckner v. Lawrence, 1 Doug. (Mich.), 19.

179. In the construction of grants, both course and distance must give way to natural or artificial monuments or objects; and courses must be varied, and distances lengthened or shortened so as to conform to the natural or ascertained objects or bounds called for in the grant, but where there is nothing in the conveyance to control the call for course and distance, the land must be run according to the course and distance given in the description of the premises. *Ibid.*

180. If a division line between adjoining lots of land is agreed upon by the owners, and is so designated as to be clear and distinct, and is acquiesced in by the respective owners of the lots for more than fifteen years, they will be held bound by such line. Ackley v. Buck, 18 Vt., 395.

181. A parol agreement respecting a boundary, made while a party is an occupant without title, cannot be binding upon him after he acquires the fee. Crowell v. Maughs, 2 Gilman (Ills.), 419.

182. When a question of boundary arises, the plaintiff may give in evidence recovery in ejectment, twenty-five years before, by one under whom the plaintiff claims, and an abandonment thereupon by the defendant. Gilchrist v. McLaughlin, 7 Iredell (N. C.), 310.

183. In Connecticut, general reputation is admissible for the purpose of showing not only public boundaries but also the boundaries of land of individual proprietors. Kinney v. Farnsworth, 17 Conn., 355.

184. Boundaries marked on the land are to govern courses and distances. Blasdell v. Bissell, 6 Barr. (Pa.), 478.

85. When the calls of a survey are all ascertained, and no resort to extrinsic evidence is necessary, it is for the Court to fix the boundary, but where parol evidence has to be resorted to, to identify the calls, the facts must be ascertained by a jury. Ott v. Soulard, 9 Miss., 581.

186. Where a patent contains a call for a corner and line not established at the time of the survey, it is not a controlling call, and will not govern course and distance. Galloway v. Brown, 16 Ohio, 428.

187. The call for the corner and line of A in a patent, is to be taken as a call for a corner and line as established at the date of the survey, and not as they may be established by A in subsequently surveying his entry. *Ibid.*

188. Of two certificates of entry, no patent having been issued on either, the oldest will hold the land, there being no evidence of fraud, irregularity, or illegality in the entry. Groom v. Hill, 9 Mis., 323.

189. A certificate of confirmation issued to the legal representatives of A, when A had sold his claim to B before the certificate issued, will not operate to the benefit of the heirs of A. Montgomery v. Landusky, 9 Miss., 714.

190. The owner of a pre-emption right has no legal title to the land, but only a right of occupancy and a right to acquire the legal title. But in Illinois, a pre-emption right may be transferred by deed as property. Delaunay v. Barnett, 4 Gilman (Ills.), 454.

191. The purchaser of a pre-emption right is regarded as the "legal representative" of the original owner, under the Act of Congress granting such rights. *Ibid.*

192. A, having a right to land by pre-emption, sold the same to B, and took from B a mortgage on the land, to secure payment of the purchase money. B afterwards obtained a patent for the same land. Held, that such title enured to the benefit of A, the mortgagee, and that B could not set up his patent title against his prior mortgage to A. Marshall v. Bush, 1 Morris (Iowa), 275.

193. Where A sells to B a land claim, for which B pays a part of the purchase money, and the land is afterwards entered by A, who sells the same to C, without notice of the sale of the claim to B, B cannot enforce specific performance of the contract against A, but he will be entitled to a decree for the money paid by him, on a bill for specific performance, under the prayer for general relief. Cunningham v. Depew, 1 Morris (Iowa), 463.

ENGINEER, ARCHITECT AND SURVEYOR.

A MONTHLY JOURNAL OF PRACTICAL ENGINEERING, ARCHITECTURE SURVEYING, MECHANICS, HYDRAULICS, MINERALOGY, METALLURGY, AND KINDRED SCIENCES.

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THE EDITORS, 168 Washington Street.

TO THE PROFESSION.

The ENGINEER, ARCHITECT, AND SURVEYOR is pre-eminently the organ of the above named professions in the United States. *It is their paper.* It does not conflict with any other scientific or class journal in the country. It is not local in its interests. The information which it seeks to convey is for daily use. Its editors are engaged in the practice of their profession and are alive to the promotion of its interests. It very justly, therefore, claims the hearty support of the Engineers, Architects and Surveyors throughout the entire country. It has already won its way to favor in every State and Territory in the Union, and it is undoubtedly supplying a want long felt.

The editors solicit the co-operation of the profession. There are engineering works in city, town and country, in progress, of which reports would be very acceptable; there are surveys being made, an account of which will be of interest; let them be duly chronicled in the columns of the ENGINEER, ARCHITECT, AND SURVEYOR. Send also the names of all whom you think might become subscribers, and by personal solicitation assist in building up a strong professional journal.

There are no subjects pertaining to the professions in which the ENGINNEER, ARCHITECT, AND SURVEYOR is not interested and it is proposed to adopt the plan of obtaining information requiring investigation, by such series of questions as those following, the results of which shall be laid before our readers from time to time. We take the liberty, therefore, to address each of our subcribers, upon the subject of *County Surveyors*, and will be obliged if each will give as free replies as possible and as unbiassed as a candid enquirer after truth *can* give.

We wish to have the answers returned to us as soon as possible so as to incorporate them in an article for our next issue.

1. Does the office of County Surveyor exist in your State?
2. If it does, is it an elective office and what is the length of the term?
3. What are the fees, and are they regulated by the State legislature?
4. What are the expenses attending the office, and what is a fair average income of surveyors throughout your State?
5. What is the law respecting surveys or subdivisions? who may make them; and is the signature of the County Surveyor an absolute necessity to make them legal?
6. Can the County Surveyor's work be reviewed, and his lines, if found incorrect, be corrected by another surveyor?
7. Are there any duties required of the County Surveyor by law, that appertain exclusively to his office, as laying out highways, establishing corners, etc.?
8. What are the laws, if any, relating to surveys?
9. What is your opinion of the Office of County Surveyor? Are there any public interests subserved by it that could not be done without it? Does it produce good surveyors? does it ensure careful and accurate surveys? does it help to elevate the profession in the public estimation, and is it an improvement on open competition between surveyors?
10. What instruments are mostly used for fieldwork in your State?
11. Why do not more surveyors use the transit instead of the compass and a light steel chain in place of the heavy iron one? what are the reasons, if any, irrespective of their cost?
12. From your acquaintance with the profession in your State, what is your opinion respecting the intelligence and skill of its members?
13. Cannot an interest in practical Surveying and Engineering be created in your State by means of such a journal as the ENGINEER, ARCHITECT, AND SURVEYOR, so that in time you would reap an advantage from it?
14. Whether you are a subscriber or not, please send answers to such of our questions as you may be disposed to, and any other information relating to surveying in your State, that only men in actual practice can give.

CHICAGO, ILL., NOV. 15, 1874.

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PARISH SURVEYING IN LOUISIANA.

We give herewith the answers on the subject of "County Surveyors" of a contributor from Louisiana, as being full of interest to the profession; and preliminary to the correspondence, some general remarks on surveying in that State.

The Territory of Louisiana was ceded by France to the United States under the treaty of April 20, 1803; by act of Congress approved March 26, 1804, that portion of this cession lying south of the Mississippi territory, and of an east and west line commencing on the Mississippi river at the thirty-third degree of north latitude, and extending west to the boundary of the said cession, was constituted a division under the name of the "Territory of Orleans," now known as the State of Louisiana.

In 1806 a plan for the survey of the public land in the Territory of Orleans was matured; and upon its adoption, contracts were let, and the surveys pushed with all possible dispatch. The reason for this haste is somewhat explained by an extract from a letter dated May 8, 1806, from Albert Gallatin, Secretary of the Treasury, to Isaac Briggs, Surveyor of public lands north of Tennessee, which runs as follows: "You will use every possible endeavor to have as much of the public lands in the western district of the Territory of Orleans surveyed during the year as practicable. * * * * * * * * It may, indeed,

in this instance, be found necessary to sacrifice the *scientific correctness* which would otherwise be desirable, to the dispatch which is indispensably necessary." The latitude given in this letter resulted in the most utter confusion and chaos of incorrect and fraudulent surveys. Before the townships surveyed could be platted, the base line run by Deputy-Surveyor John Cook had to be run anew; and, in forty-seven miles eastward from the initial point, the new line fell more than 1,200 yards to the north of the old line, while to the west of the initial point Cook's line was found to be a zig-zag, incongruous line, which in thirty-six miles had gained to the north, over 600 yards. The "basis meridian" was run in the same careless manner by Deputy-Surveyor Thomas Owings; and, although a great deal of "patching" has been done by the government to correct these erroneous surveys, the consequences are felt to the present time. In other districts of the State the surveys were conducted in an equally loose manner. French and Spanish customs governed in many places; titles were granted by the U. S. Government, which further complicated matters; disputes between surveyors arose to help the general muddle; and it was only by expensive re-surveys, and a properly organized surveying district, and liberal appropriations, that the complex problem of harmonizing the surveys of Louisiana could be solved. This work, commenced in 1836, is still being carried on; and so thoroughly has it been performed that it is unexcelled in the United States for precision, and for the mass of useful and exhaustive information obtained. We would like to draw farther on the very interesting report of the Surveyor-General of Louisiana for 1873, but must yield to our correspondent.

REPLIES TO INQUIRIES ON THE SUBJECT OF "COUNTY SURVEYORS" ON PAGES 108, 144.

1st. The office of "County (Parish) Surveyor" exists in Louisiana.

2d. It is filled by appointment from the Governor, without any limit to the time of tenure prescribed by law. Bond to be given for $2,000.

3d. The fees are fixed by the laws of the State, as follows:

For mileage in going to and returning from any place where a survey is to be made, per mile	$0.12½
For measuring the front of any tract of land, or any bayou or river, for every arpent (2.09 chs.) running measure	0.25
For measuring depth lines where the lines touch cypress swamps, and for measuring back lines, for every arpent	0.25
For running a straight line, for every mile	4.00
For meandering a water course, for every arpent	0.25
For every plat, including the record	5.00
For every certified copy of such plat	2.50
For planting every corner post	1.00
For every additional tract of land comprehended in a plat, with surveys and boundaries established	5.00
For measuring every lot in a town, or other place divided into lots, for every foot	0.01
For every original plat of any such lot, including the record	3.00
For every certified copy of such plat, and of the certificate of survey	2.50
For every addition tract in a connected plat	2.00
For every over or fraudulent charge, there is a penalty of restoration of the fee, and a fine of,	50.00
Surveyor's help, allowed per day	1.00

Surveyors empowered by law to administer oath to chainmen.

4th. The expense of a parish surveyor, in many cases, would exceed the legal fees if honestly made out, and it is not a paying office.

Surveyors cannot well average over 100 working days in a year, which at the rate of $10 to $15 *per diem*, would give the maximum of a private surveyor's income. Some private surveyors do not work by the day, but "lump it by the job."

5th. A special law, under the reconstruction or carpet-bag government, requires that all lands sold under "execution or writ of seizure and sale, shall be divided into "lots of not less than 10 nor more than 50 acres," which may be done by the "Parish Surveyor;" or if there be none, by "any competent surveyor or other person," which seems to imply that if a "competent surveyor" cannot be had, any ignorant ass would do. This law was passed for the purpose of tearing to pieces the magnificent estates and parceling them out among negroes.

But as negroes have no eye to saving money for such purposes, and as there is little or no other market for lands in Louisiana, the forced or seizure sales which occur every day, being but processes to transfer title from debtor to creditor, these divisions are merely simulated and the surveyor loses his chance for a fee.

The fee fixed by law in this case, is $4.00 per mile, and "25 cents for bearing or corner," whatever that may mean. Out of this the surveyor must pay his own expenses, hand-hire, &c., and furnish a plan.

The signature of any surveyor appointed by a court of competent jurisdiction, in a particular case, is as valid as that of a Parish Surveyor, if the survey be made the judg- of the court.

In other cases the signature of the independent or private surveyor will depend for its force upon the agreement of the parties interested.

6th. The work of a Parish Surveyor can be reviewed by another surveyor, and if found incorrect can be corrected by an order of court.

7th. There are no duties required of the Parish Surveyor, by law, which appertain exclusively to his office, and which may not be executed by any other surveyor.

8th. Laws relating to surveys. The lines and corners established by U. S. Surveyors, are the basis of all surveys in the State. They can only be changed by an application for resurvey to the U. S. Surveyor General.

In making subdivisions regard must be had to the general principles of the U. S. system as far as practicable. In many portions of Louisiana land is laid out after the French and Spanish system of small fronts measured in arpents on navigable streams, by great depths, as nearly perpendicular to said streams as may be, in order, first, to accommodate as many as possible to the advantages of navigation; secondly, to reach the cypress swamps in the rear for lumber privileges; and, thirdly, for general mutual protection and sociability.

The laws of Louisiana are latitudinous enough to preclude finality in any disputed point of surveying, unless taken through the journey of the courts, to the exhaustion of one or both parties.

9th. The office of Parish Surveyor, if properly protected, conducted, and enforced, would be a valuable institution; but as it is, it is principally sought after by beginners, strangers, and incompetents, as an advertisement by which to force themselves into notice. There are, really, no public interests which cannot be subserved without it. It does not produce good surveyors, does not ensure careful and accurate surveys, does not particularly, or *per se*, help to elevate the profession in the public estimation, and is no improvement, that I can see, on open competition between surveyors.

10th. The principal instrument used for field work is the vernier staff compass.

11th. The compass is preferred to the transit, because of the greater ease in making time through the tangled woods and dense undergrowth.

Aside from the extra cost, I know of no reason why the light steel chain is not patronized, except that they are not brought to the immediate notice of the surveyor and placed within his reach.

12th. There is much talent and education in the profession in Louisiana. Some of its members have acquired a reputation far beyond the limits of the State—almost national. Among the practitioners, however, of common land surveying, there is much ignorance and incompetency. The cause of this may be briefly illustrated, thus:

A young man of common school education. engages on a survey as chainman or rodman. In time he learns the use of instruments, and gets into the routine of common work. To save the expense of a competent man, he is trusted to some simple work. He finds himself filling the position of an engineer, and within a certain beaten path he does the work equally well. In his ignorance he believes himself a full fledged surveyor, and claims to be such. Not being required to stand an examination, or to exhibit a diploma, to be admitted to practice, and by virtue of the ease with which recommendations are obtained, he readily finds employment at reduced rates, which indeed are very handsome for him. Thus ignorance creeps into the profession, and competent men are compelled to compete with the incompetent fledglings, and to experience a degradation both personal and professional.

13th. I believe that the profession can be greatly dignified and elevated by the proper circulation of a journal like yours.

The decisions of the Courts of the U. S., in contested land cases, as rendered in your "Law and Legislation," will form a most valuable source of assistance to the Parish or County, or other surveyors.

Surveyors have never had a medium of inter-communication for the purpose of interchanging opinions and experience, which being accumulated in each case, would result in valuable improvement to all. I know of no class of men who are so little acquainted among themselves as surveyors; who assist each other so little; or among whom there is as little fraternal feeling. If your journal can rectify these failings, I shall certainly hail it as one of the greatest blessings to our poor, unorganized, and, I may say, God-forsaken profession.

E. G., Parish Surveyor,
Plaquemine, Iberville Parish, La.

OUR NOTE BOOK.

A correspondent has written us, complaining of the number of *serial* papers which we publish. He rightly supposes that we have many important papers in hand only waiting for room to make their appearance in these columns. Knowing the varied class of our subscribers, our only plan at present of presenting the greatest variety of valuable information in the shortest time, is by this system of serial publication. Directly the number of subscribers on our list will justify it, the Journal shall be enlarged, but until that time though we shall bear our correspondent's remarks in mind, believing them to be made in a friendly spirit, a certain proportion of our matter must appear in serial form.

Another correspondent who has lived for years in California, engaged in engineering and surveying works, calls our attention to Tule Land Reclamation, p. 88 *ante*. He states that the plan therein recommended of making the levee of alternate courses of tule roots (the plastic material mentioned) and mud from the river, is not a good one, as the tule-roots, in their decay become highly pervious to moisture, in fact, of the same consistency and appearance as a bed of farm-yard manure. Where tule is live and growing, however, it forms an excellently firm building locality, as the roots for a depth of four feet below the ground surface grow strongly matted together.

We shall be pleased to receive from our correspondent who sent us replies from New Jersey on the subject of County Surveyors, any information he may have on the subject of Cement *v.* Stoneware Sewerage Pipes.

We have received communications in answer to our questions on the subject of "County Surveyors," from the States of Wisconsin, Minnesota, Missouri, Ohio, Texas, Louisiana, and New Jersey, and we are pleased to see the great interest shown in the subject by our correspondents. We publish on page 145 the answers of a correspondent in Louisiana, and especially solicit a free correspondence on the subject from surveyors in *all* the States of the Union, so that very shortly we may be enabled to lay the results before our readers, and inaugurate a movement that may be of general benefit to the profession. Certainly, from what we now know, there is great need of improvement, and it is important to surveyors throughout the Union, to begin, before the State Legislatures meet, to devise means whereby they may elevate the standard of the profession, and increase the ridiculously low fees that are now paid for their services. County Surveyors! take a little trouble on your own behalf! You *ought* to be a body of men whose influence throughout the land could be made an important factor in politics; let each man do his best and you *will* be.

CORRESPONDENCE.

OCONTO, WIS., Oct. 13th, 1874.

MR. EDITOR:

I have read every number of your paper with deep interest, and believe it to be of the greatest value to the profession in whose interest it is published. Its value as a medium of information, and exchange of opinion, must be highly prized by every intelligent surveyor and engineer.

With your permission, I wish now to avail myself of the use of your columns, to speak of two points in the subdivision of sections, and thus add my mite towards inducing uniform rules of practice for surveyors. These two points are: First—How to establish the corners for half quarter and quarter quarter sections; and Second—How shall the interior lines of a fractional section be run, when no opposite corresponding corners have been or can be fixed? Mr. Hawes in his really valuable work on "United States Surveying," at page 136, says: "All the subdivisional lines of a section must be straight lines, running from the proper corner in one exterior line to its corresponding corner in the opposite boundary of the section. THERE IS NO EXCEPTION TO THIS RULE."

I have good reason to believe that the general practice is not in accordance with this rule, although it has its adherents, and among good surveyors. You have already published your decisions on this point, and I see by your "Correspondence," that most of those expressing an opinion are in accord with you. But there are still good surveyors who practice "Hawes" rule. Therefore I adduce some arguments which I have never seen in print.

Mr. Hawes considers the rule he lays down as the only possible construction to be deduced from the act of 1805. Let us examine carefully this and subsequent acts, so far as they have to do with the matter in hand. The only direction contained in the act of 1805, for locating the subdivisional corner of a section, is found in subdivision one of section two, and reads thus: "All the corners marked in the surveys returned by the Surveyor General, or by the Surveyor of the land south of the State of Tennessee respectively, shall be established as the proper corners of sections, or subdivision of sections, which they were intended to designate; and the corners of half and quarter sections not marked on the said surveys, shall be placed as nearly as possible equidistant from those two corners which stand on the same line."

In Acts approved April 24th, 1820, and April 5th, 1832, is found the following: "And the corners and contents of half quarter and of quarter quarter sections, which may thereafter be sold, should be ascertained, as nearly as may be, in the manner and on the principle directed and prescribed by the second section of" the act of Feb. 11, 1805. To use a legal phrase, these acts are "in *pari materia*, and must be construed together." Thus the law, in so far as it relates to the matter under consideration, is: "the corners of half quarter and quarter quarter sections shall be placed, as nearly as possible, equidistant from those two corners which stand on the same line." Are not the corners between the centre of the section and the exterior quarter section corners, half quarter and quarter quarter section corners? Are not the centre quarter section corners and the exterior quarter section corner "those two which stand on the same line" as the intermediate corner? And then must not the last corner be equidistant between "those two?" Every surveyor, at all experienced in the public surveys, knows that corners thus placed will differ from the same corners established by the rule laid down by Mr. Hawes. I argue this question no further, but would be pleased to see the arguments upon the other side clearly stated.

I now turn to the second point. Mr. Hawes in his book already referred to, at page 136, lays down the following rule: "5. In fractional sections, where no opposite corresponding corners have been or can be established, any required subdivision line of such section must be run from the proper original corner in the boundary line, due east and west, or north and south, as the case may be, to the water course, Indian reservation, or other exterior boundary of said fractional section." The then Commissioner of the General Land Office, Hon. Joseph S. Wilson, sanctioned this rule. Both were positive in the conclusion that the law of 1805 would not admit of the construction, allowing the exterior lines of these sections to control the course of the interior lines.

William A. Burt in his "Key to the Solar Compass," at page 74, says:—"The quarter section lines should be run with an intermediate course between the section lines, and the fractional quarter sections thereof should be divided in like manner."

In the year 1870 I issued a circular with illustrative diagrams, inquiring as to what the practice was, and had been, requesting diagrams and notes in cases of important surveys of fractional sections, reports of decisions of courts upon such surveys, and all relevant and important information. These circulars I addressed to Surveyors in all the Public Land States. I stated that a pamphlet would probably be issued containing all the interesting information thus elicited. Replies poured in upon me, showing the interest in the question to be much deeper and more general than I had expected. Much very valuable information was given, and many surveyors of high standing replied at length. Plats and abstracts of surveys were sent me. One surveyor sent me a plat of a survey made when Albert Gallatin was Secretary of the Treasury, wherein he had instructed the Surveyor in a case exactly in point. This I take to be of great importance as a precedent, because the Secretary of the Treasury, then in charge of the Public Lands, directed the operations of United States Deputy Surveyors, *by whom these subdivisions were then made.* In this case, and as shown by ninety per cent. of all the replies sent me, the intermediate course rule was adopted. The "Engineers and Surveyors' Association" of Michigan, endorsed this rule. No reports of decisions of courts were sent me.

I found this correspondence expensive in time and money. I had not time or means to properly embody the result in a pamphlet form, although many of the letters, agreements, and plats were very valuable. One point brought out was, that the history of legislation upon the subject, and the acts of Congress, in their sequence, must be attentively considered, to arrive at a correct interpretation of these land laws.

I have thus stated the general result of the correspondence, and hope to avail myself of the use of your columns, to express my grateful sense of the warm interest, and, in many cases, laborious research, and careful and intelligent statement of the facts, apparent from the replies to my circular. The interest and courtesy thus manifested were not at all confined to those who supported the general view. Able arguments were made by those practicing under the Hawes rule, if I may call it so. This proves again how necessary is an uniform rule in these cases.

Respectfully yours, R. L. HALL, Surveyor.

METAMORA, IND., Nov. 3.

Editors of ENGINEER, ARCHITECT AND SURVEYOR.

We have an Indian Boundary line running across our county. Some of our Ex. Co.-Surveyors assert that in running a line a boundary of that class cannot be crossed. What is your opinoin? F. A. H., Co. Surveyor.

ANS. An Indian boundary line *cannot* be crossed, except where the Government Notes show that it has been disregarded in the original survey. Such lines exist in townships to the north and south of Chicago and parts of sections are described as being North and South of the Indian Boundary line. The surveys on each side were independent of each other and lines do not join. But where the lines have been run across the Boundary line, this latter need not be regarded, except to note them as circumstances may dictate. EDITOR.

Other correspondence is unavoidably postponed until our next number.

SEWER PIPES: CEMENT v. STONEWARE.

[CONCLUDED.]

The ignorance of workmen as to the proper treatment of cement, together with the poor quality of cement used, and the desire to produce as cheap an article as possible, all led to confirm the existing antipathy toward it; but that has given, or rather, *is giving* way, at present, to a more favorable impression; but our Councils have not yet authorized the use of it for sewers. We are putting in two short pieces of it to drain surface water across two streets. My own opinion is that pipe made out of a good quality of Portland cement, "English" or "German," not too much reduced by a disproportion of sand, will stand the test required. In this opinion I am confirmed by the success with which it has been used in London, and a single test that has been made here, where cement has not been injuriously affected by the action of urine; but the liability to get *poor cement*, even of the best brands, and the difficulty to get careful workmen to properly manufacture the materials, and the difficulty to discern any flaws that may be in the pipe, have been deemed sufficient reasons not to allow its introduction here to any great extent. The manufacturer here is one of the most extensive contractors, and he is endeavoring hard to introduce his pipe wherever he can do so, guaranteeing it for a length of time. He has now come to the use of "Portland Cement," in making sewer pipe. We have a company here making "artificial stone," with the same quality of cement, and I have paid close attention to their work, examining the cement closely, and the conclusion to which I have come is that too much care cannot be exercised in the choice and manipulation of the material, and if care is not exercised the most unsatisfactory results will be produced, but as I have said there has not been time enough given here to tell from any extended experiments whether pipe properly made will withstand the action of the acids to which they are exposed in sewers, and therefore a positive opinion, based on actual experiment and observation cannot be given.

I think that pipe properly made of the cement I have mentioned *may stand*, but I would not like to risk it in any extensive work; but I do not *think* it will stand if made of any other than *that quality of cement.*

A. DEMPSTER, City Engineer, Pittsburg, Pa.

We have used the cement pipe manufactured in this city in two instances only.

Our sewers for city purposes are large—from four to seven feet in diameter—for which we use hard burnt brick in their construction.

Our experience with the cement pipe has been such as to compel us to report unfavorably upon its future use.

Two years ago we laid about 100 feet of the pipe, six inch diameter, for the purpose of drawing a spring; about six months ago we were obliged to open it for repairs, it having failed to drain, when we found it had softened or yielded to the action of the water to such an extent as to render two sections useless.

In regard to the "stoneware," or glazed pipe, I can say nothing officially not having used it for city purposes. It is, however, quite extensively used for private sewers, and seems to answer very well.

JOHN H. TEGMEYER, City Engineer, Baltimore, Md.

Here the use of cement pipe was discontinued after a short trial, and the vitrified salt glazed pipe exclusively used in the construction of our pipe sewers, connections, &c., which I think to be quite superior to any cement pipe which I have seen tested, in eveness of texture, firmness, durability, and its qualities to resist the action of sewer acids.

H. C. THATCHER, City Engineer, Toledo, O.

The experiments I have made with cement sewer pipe are, that I filled a pipe with salt and water, and find that salt acts on them so that I think it would eat a hole through in no very long time. Acids will have a greater effect on them. And I know of no means of ascertaining which are good and which are poor. In our city here, for the above reasons, I recommended the use of vitrified stoneware pipe, which was adopted by the City Council. H. H. CARSON, City Engineer, Minneapolis, Minn.

We have no sewerage here worth mentioning. What we have is of the vitrified "stoneware," with the exception of cement pipes laid from the hotel to the river. I have not had an opportunity of examining the latter, but am inclined to prefer the vitrified pipe.

J. H. HUMPHREYS, City Engineer, Memphis, Tenn.

My opinion in regard to cement pipe is the same as your own. Have found the same difficulty in regard to the texture of the pipes not being equal. Any one can see at a glance that the cement pipes will absorb the acids of the sewer, which will certainly destroy them. Were the sewers under my charge I should certainly use the vitrified pipes for their conducting power alone, the polished surface presenting little or no resistance to the water and foreign matter. I do not know what patterns you may have, but the sleeve-joint of our stone pipes is much better than that of the cement pipes. I am interested to know what the result will be. Should you have the leisure or inclination to respond, please address

NAT. ABBOTT, City Engineer, Augusta, M

The branch sewers in this city are generally built of brick, and vitrified clay pipes are used for attachments and house drainings, and occasionally for short distances in streets.

Cement pipes are manufactured here on a limited scale, but so far as my observation goes, have not given satisfaction. So much care is required in obtaining good material, and having them properly made, that the quality cannot be depended on. Although somewhat cheaper than the vitrified pipe, there is so much uncertainty in them that I should not be willing to risk their general introduction.

Cases have been reported to me of cement pipes where they have all had to be taken up, on account of their deterioration. Brick are cheaper here, and of such excellent quality that they have the preference for large-sized drains.

S. S. SMEDLEY, Chief Engineer, Philadelphia.

Natchez has never been, is not now, nor will,I think, as long as governed by negro gentlemen, be blessed with any sewers beyond brick culverts.

The Natchez, Columbus and Jackson railroad, now in construction, Col. S. M. Preston engineer, are using vitrified piping for culverts in preference to cement pipes. What their objections are I am not aware of.

CHAS. E. NAUCK, City Engineer, Natchez, Miss.

In reply to your inquiries in regard to relative value of cement and stoneware pipes, I can only say that I have used stoneware pipes with entire satisfaction. Specimens of cement pipe have been left at this and other cities. They are too delicate for use and fall to pieces with the slightest blow. We have local manufactories, which make very fair stoneware and earthenware pipes, at reasonable prices. I can see no good reason for abandoning them for a mere experiment

HOLLAND WHEELER, City Engineer, Lawrence, Kan.

Recently, our Board of Street Commissionners decided on my recommendation not to lay any more cement tile. I was led to give this advice from a general idea of their worthlessness, which has been proved in several cases when we have taken up such sewers, some of quite recent construction. We found length after length entirely crumbled, and others that we succeeded in lifting out of the trench would break with a very slight blow I think your reasons all hold good, and are sufficient to condemn their use.

We also object to the glazed tile, from difficulty of entering them for side sewers, as we have not yet adopted the plan of laying side connection when we lay the main sewer. We shall, in accordance with the above decision, hereafter lay nothing but brick sewers, the smaller ones of oval form, the larger ones circular. If our experience is worth anything to you I am glad to be able to give it to you.

C. H. BUNCE, City Surveyor, Hartford, Conn.

My experience has led me to the conclusion that vitrified, or glazed pipes, are superior in every particular, and I have ordinarily endeavored to use as little cement pipe as possible. There can be no real question of which is the best.

I have given this subject the most thorough attention, and I am confident I am right, and time will prove it. Cement pipe never will answer a safe purpose until it can be manufactured so as not to become disintegrated after being laid in the trench and covered. I have known a sewer to cave in built of it, and make a most disagreeable state of affairs, from the fact of not knowing to what extent the break extended.

JNO. P. CULVER, Chief Engineer, Jersey City,

Within the last year I have passed through an experience in sewer piping, with a conclusion fully in accord with your own. My mind is settled on the superiority of stoneware pipes, and the uncertainties attending those of cement. I will not hereafter use the cement pipes in our city sewerage.

CHAS. H. DIMMOCK, City Engineer, Richmond, Va.

I believe that cement pipes have not been at all used in Wheeling, for sewers, unless it may have been by private parties, of which I have no knowledge. My opinion would be decidedly in favor of the glazed pipe, within range of capacity suited to its strength.

W. C. SMITH, City Surveyor, Wheeling, Va.

In this city we use for the smaller local sewers glazed stoneware pipe. No cement pipe whatever is used. I have used cement pipe in railroad drainage, and found that it breaks easily. My opinion is that the stoneware pipe is decidedly preferable to the cement pipe for sewer purposes.

GUSTAV SCHLBACH, City Surveyor, Newark, N. J.

I should much prefer the stoneware pipe, as your assertion that the cement pipe is seldom of a perfectly uniform texture, and is very easily broken, is true; and I don't consider it as safe and durable as the stone pipe. If you have laid much of the cement pipe, I think your experience has taught you that, when the cement pipe is saturated with water, it becomes very difficult to lay with success; and, unless I was laying sewers of very large calibre, where I could lay it in the ground like concrete, I should much prefer the stoneware, as I am satisfied it will be as enduring as time.

W. D. CLARK, City Engineer, Springfield, Ill.

In my opinion "stoneware" pipes are far preferable to those of cement. Your reason for abandoning the latter is, as far as my experience goes, perfectly correct, viz: the want of uniform texture, the influence of acids, and easier breakage.

We have used in our city extensively the stoneware pipes, and have found the same, when hard burned, well vitrified and glazed, to answer all reasonable demands.

GEORGE WEHE, City Engineer, Little Rock, Ark,

As an answer to your questions concerning cement pipes for sewers, etc., I will state that the city of New Haven has used nothing but cement pipes for the pipe sewers that have been constructed here, and large quantities are still being used. Thus far we have had no trouble with them; and, so far as I have examined them where they have been down a number of years, to all appearances they are better than when first laid.

E. S. Chesbrough, Esq., City Engineer of Chicago, who is the author of our "Sewerage System," does not approve of their use here, and we consider him the best of authority. Probably the pipes made here are as good as any in the country, and appear to stand well wherever used; still, for all that, I do not approve of their use. I believe there are other drain pipes made which can be relied on, without any doubt; and to see such quantities of cement pipe used here in the construction of our sewers causes me some uneasiness, for the time may come when we shall find that the experiment has been tried on too large a scale.

CHAS. E. FOWLER, City Surveyor, New Haven, Ct.

We have no experience as to cement sewer pipe in this city, never having used any but the Scotch vitrified ware, and no other can be used unless the ordinances of the city are changed.

As with you, a pressure is made on our Board of Aldermen by the manufacturers of cement pipe here, to have their pipe substituted, but thus far without success. I am prejudiced against their use, except for clear water; have examined the process of making cement pipe, and do not believe that sufficient care is taken to have them of uniform texture, and that if sufficient water be used to make the mass homogeneous, the time taken to have the pipe properly made, and the cement well set, would make the cost of cement pipe as great as vitrified ware. The question is now being agitated here. I intend to make some investigation in this direction, as soon as I can spare the time; uutil then, I do not believe any change in the character of pipe will be made by our Board of Aldermen.

A. H. FONDA, City Engineer, Paterson, N. J.

We have never used the cement pipe, though often urged to do so; therefore, I cannot speak from experience, but have been told of instances where sewerage has taken the life out of the pipe, so that it crumbled to pieces.

The Committee on Drainage have examined the subject at different times, and have always used brick or stoneware for sewers.

A few private parties have used the pipe, and I have noticed that there was a difference in the prices. Some were hard, and others would crumble in the hand. I have been told that in Salem and Boston they have been obliged to take up some cement pipe which had been laid only a few years.

ISAAC K. HARRIS, City Engineer, Lynn, Mass.

The sewerage department of this city have used no cement pipes, for the same reasons that you name, although they are made in this city and used for that purpose by private parties. The very best imported pipe are used for sewers. I can see no reason why the cement pipes should not be used to a limited extent, where the circumstances are favorable, and where not subject to the action of acids. There seems to be some difference of opinion among practical men about them, but in deference to Mr. Shedd's opinion, (the Chief Engineer of the water-works,) there are none now used by the city.

CHARLES E. PAINE, City Engineer, Providence, R. I.

This city has made but very little use of cement pipe of any kind; but the Omaha and Northwestern Railroad Company have had in the neighborhood of 1,500 feet placed upon their road some six months ago, all of which proved a failure, owing to their want of sufficient strength to support the requisite pressure.

From my observation of the pipe, I should not recommend it for sewerage purposes:—

1. Because they are more or less subject to disintegration from acids.
2. Their peculiar construction requires a better class of skilled labor in the setting than is usually secured.
3. Their efficiency depends so much on the peculiar selection of material entering their composition, that few manufacturers manage to secure a proper cement, and proportion of clean gravel or sand requisite in pipes for sewer purposes.

ANDREW ROSEWATER, City Engineer, Omaha, Neb.

We have as yet but little experience in sewerage in this place. I have made some inquiries as to the best material, and the general opinion is that the hard burned, well vitrified stoneware pipes would be preferable, for sewerage. to cement.

GEO. W. STUDEVANT, City Engineer, Keene, N. H.

CIVIL ENGINEERS' CLUB OF THE N. W.

The November meeting was held on the evening of Monday, the 9th inst, at the Club Rooms, No. 145 Clark street, Room 52. The President, E. S. Chesbrough, occupied the Chair. There were present eighteen members.

After the minutes of the last meeting were read and adopted, C. W. Irish, C. E., of Iowa City, Iowa., was elected a member of the Club.

A paper by O. S. Chanute, Chief Engineer of the Erie Ralway, entitled "Note on Repairing a Bridge during a Flood," and which we print in full below, was then read by the Secretary, and remarks thereon were made by several members of the Club.

Gen. W. S. Smith directed attention to several points of importance in rip-rap work, and the President to some recently discovered peculiarities of wave action at great depths, imparted to him by a well known submarine diver of Detroit.

The circular of the American Institute of Civil Engineers, calling for plans and estimates for a "Method of Rapid Transit in New York City," was then read.

The Constitution was amended by changing the day of meeting from the second *Monday* to the first *Tuesday* of each month, and by a unanimous vote the hour of meeting was changed from 8 P. M. to 5.30 P. M.

The Executive Committee reported that they had closed an agreement with the Chicago Chapter of the American Institute of Architects for the use of their rooms (the ones now occupied), for one night each week, the rooms to be accessible at all times to every member of the Club.

The matter of printing the papers and proceedings of the monthly meetings was referred to the Executive Committee, with power to act.

The steel standard measures of 4 ft. and 6 ft., sent by the Club to Washington, for comparison with those in the office of the U. S. Coast Survey were returned to the Club corrected, but without the signature of Prof. Hilyard, the officer in charge of the U. S. Standards of Weights and Measures, who is now absent in Europe. The presence of the standard measures, brought up a conversation in reference to the Board of Public Works standard in the City Hall, referred to on page 85 of this journal, and the blame was finally laid upon the Gurley chain mentioned in that article.

A vote of thanks to Mr. Chanute, for his interesting and valuable paper, was passed; also to the Publishers of the ENGINEER, ARCHITECT, AND SURVEYOR, for a complete file of their Journal and Binder presented to the Club, after which the meeting adjourned.

Mr. O. S. Chanute's paper was as follows:

The traffic of our leading Rail Roads is growing so important, its interruption even for a single day causing so much inconvenience and expense both to the public and to the Rail Road companies, that a brief account of some expedients which save time, a simple leaf from a note book, such as Engineering Societies are always asking for, and seldom get, may not prove uninteresting.

Some years ago the writer was in charge, as chief engineer, of the construction and maintenance of way on the Chicago and Alton Rail Road. This road crossed the Kankakee River at Wilmington, Illinois, with several spans of single track Howe truss bridge, duly covered and housed in, and resting upon masonry abutments and piers. The River at this point flows rapidly over a smooth limestone ledge, which is covered with only two or three feet of water during the dry season. Above the bridge is a tranquil reach of the river, of considerably greater depth, on which the ice freezes to a great thickness. The lower chords of the bridge were some thirty-five feet above the bed rock.

Very early in the spring of 1866, the Kankakee River broke up in the vicinity of this bridge, with a sudden thaw and freshet. The winter had been rigorous, snow was on the ground, and the ice was from three to four feet in thickness, clear, solid, and hard. The thaw and accompanying rain caused a flood in the river; it raised some fifteen or twenty feet in the night, and brought down large masses of ice against the piers. These were of good size and well built, they resisted and stood, save one pier, which being more severely exposed than the rest, was seriously injured and nearly half demolished. It is probable that some of the stones in the inclined ice breaker with which the upper starling was provided, were displaced by the lateral shove of the first fields of ice which came down. Once an opening effected, subsequent fields and cakes of ice disloged stone after stone, cut away the piers as far back as the centre of the track, and virtually sheared off the upper half of it.

About eleven o'clock in the morning, when the writer reached the scene, the bridge still stood, but seemed in great jeopardy. One chord overhung the water without support, the other rested upon the remainder of the pier, which had been destroyed to within some four feet of its edge. The ice was still running, and having gorged above, was coming down at times with one cake on top of another, thus pounding the pier with six feet in thickness of clear ice, and dislodging additional stones. The water had risen to within some six feet of the chord, and was running some 10 feet per second, or 7 miles per hour.

Fortunately the thaw had not continued, the run of the ice was drawing to a close, and the river had ceased to rise. It was therefore hoped that the worst was over, and that the bridge might continue to stand, although one side was unsupported.

The trusses had been framed with continuous chords so that they extended over into the adjoining spans. This mode of framing, was nearly obsolete for wooden bridges, and objectionable in many ways, yet proved on this occasion the salvation of this structure. The chords being continuous over the supports, the destruction of one of them did not involve the immediate fall of the bridge, for the weight of the unsupported portion was partly balanced by that of the adjoining spans. The bridge had settled over towards the up-stream side and was unsafe to cross, but if the pier was not further destroyed, it was not in imminent danger. Of course all traffic over it had ceased, and as it was feared, for many days, until the river should fall so that work might be done in it.

The first step taken was to put in diagonal braces inside of the bridge, from the underside of the top chord on the unsupported side, to the top of the bottom chord on the sound side, in order to transfer as much of the weight as possible. The next was to arrange a fender of floating timber above the ruined pier, to ward off the ice which was still pounding it. This did not succeed very well; it was knocked away twice, and finally abandoned.

The next step was to devise means for the speediest possible support of the overhanging chord, in order to resume traffic over the bridge. It was evident that all that was required was a firm support under the up-stream side, in place of the portion of the pier which had been destroyed, but the question was how to obtain and keep it.

The stream was rolling beneath about 30 feet deep, at a speed of 10 feet per second, over a smooth rock ledge; and engineers who have had to carry on any work in water flowing at such speed, will readily appreciate the difficulty of handling any material in a current which exerts a pressure of 200 pounds per square foot.

Of course the first idea which suggested itself. was to place a bent of timber under the overhanging chord, but this would have been swept away very soon by the flood, or knocked out of the way by the running ice, which still kept coming. The experience with the fender was conclusive on this point. The next was that of a crib, to be filled with stone, and sunk, but this would have required time to frame it; there was no timber and no boats at hand, and its mass would have been so great as to make it almost impossible to handle and place it accurately in the current then flowing. It would probably have been lost, and perhaps some lives with it.

A better idea occurred to the writer; he determined to build a stone island in the river, to support the overhanging chord, and within twenty minutes after his arrival, orders were telegraphed to load two trains with rubble stone in the prison quarries at Joliet. The prisoners were at once turned out, the trains loaded, and by dusk, some 20 cars of stone had arrived.

The theory was this: As the river was flowing at the rate of 10 feet per second, it would at once sweep down stream, and out of useful reach below the pier, any stone dropped gently into it, say through the bottom of the bridge. If however the stone should reach the surface of the stream, at a higher velocity than that of the current, it would fall through the water, at an angle which would be a component of the velocity due to gravitation and that of the river. This was 10 feet per second, while as the top of the bridge was some 28 feet above the water, it was possible by tossing a stone from thence, to have it strike the water at a speed of 43 feet per second.

This however was scarcely practicable, as the sloping roof of the bridge afforded no footing. Nor was it very desirable, as it was possible to toss the stones out at the side and obtain a fall of 16 feet, and a speed of 32 feet per second, at the moment they struck the water. From these data, it was roughly calculated that the stones would fall at an angle of 20° or 30° degrees from the perpendicular though the water, no account being taken of the acceleration due to gravity nor of the retardation due to falling through a denser medium than air. These angles would take the stones to the bottom, well within the length of pier, and made it possible to build an island of stone, without extending over a very great base.

So soon as the cars loaded with stone began to arrive, it was ascertained by cautious experiment that the bridge was still strong enough to carry a single loaded flat car, if pushed slowly by hand to within a few feet of the damaged pier. A large gang of men having been gathered together, holes were cut through the housing of the bridge on the up stream side, at a height of about twelve feet above the rails,and a rough platform constructed for the men to stand on, just beneath them. The flat cars loaded with stones were run one at a time upon the bridge, and stopped as near the holes in the sides as was deemed prudent to go. Men upon the cars passed the stones to other men on the platforms, and the latter threw them in the water, being instructed to toss them in the air, and as far up stream as they could. The men were divided into squads, those who tossed the stones were relieved every two hours, and all were served with a warm supper at midnight. The work continued all night, car load after car load disappearing in the water without indication as to what progress was being made. At length, about three in the morning, when 19 car loads had been tossed in, the stones could be heard striking striking against each other under water, and at daylight they were up above the surface, presenting an apex of loose stones about 6 feet square.

The carpenters were now aroused, and set to framing a bent of four posts, which resting upon a timber foundation on the stones, extended up to the bottom of the chord. The latter having been raised up with jack-screws, folding wedges were inserted between it and the bent, and the bridge pronounced safe for trains; traffic being resumed over it about 10 A. M., or within 24 hours from the time that a plan was decided upon for its repair.

The water was still running fast,and did not fall for several days. Ice was still coming down occasionally, which struck the stone island, and displaced its materials; but watchmen were kept night and day to tighten up the folding wedges after every train, and more stones were added on the up stream side, some 40 car loads in all having been put in.

When the water finally fell, so that the work could be inspected, the island was found to be very nearly conical, with quite regular slopes, and encircling the ruined front of the pier. It was removed during the low water season and the pier properly rebuilt.

This experience suggested the inquiry, as to what could have been done, had the chords not been continuous, and the two spans resting upon the pier had fallen. A plan was devised for building trestle work across a rapid stream flowing over a rock bottom, which was partially applied by the writer the succeeding year, while building the bridge across the Missouri River at Kansas City. It was there desired to build a trestle from the shore to the first pier in the river, in order to carry over stones for its construction, and to serve as false work for the exterior of the superstructure. The distance was about 100 feet, the bottom a ragged, irregular rock, and the current four or five miles per hour.

A balanced beam was prepared on shore, capable of swinging a heavy bent into position at the required distance (say 20 feet) beyond its last support, the inshore end being properly counterweighted. Bents were then prepared, without caps or sills, and consisting of two posts sloping outward from the top. These posts were tied together with horizontal two-inch planks, spiked to them on both sides, and thus forming a flat deep box of the whole size of the bent. This was divided into three compartments by two vertical planks set on edge inside, between the horizontal covering planks and spaced about 18 inches apart, at the centre between the posts. The two side pockets of the three thus formed were provided with a bottom spiked to the covering planks, a short distance above the foot of the posts; the central space forming a sleeve, was left open. All the horizontal covering planks were fastened to the posts with single spikes at each end, and spaced about one inch apart, so that the whole bent was limber, and could be racked laterally to adjust itself to any minor irregularity of the surface, when it came to a bearing with its two legs on the rock, which was rough and jagged. Soundings had previously been taken, by which the bents had been framed, but the rock was so irregular that a change of position by a few inches, might have given trouble had the bents not been flexible. Sway brace planks were bolted on opposite sides at each lower corner, pivoting on the bolt, and lashed alongside of each post, until the time came to unfold them to the opposite corner in order to change the flexible bent into a rigid one.

The bents thus prepared of rough timber, were swung by the balanced beam over the position they were meant to occupy. They were swung sidewise at the bottom of the current, and hung diagonally down stream out of line, being entirely too light in themselves to possess any stability. Stones were now filled in the side pockets through a hopper, and the weight thus added to the bent caused it to hang nearly vertically from the balanced beam, and to come to a bearing upon the rock bottom. About 20 tons of stone were thus placed inside of each bent, care being taken to throw in none that were likely to jam. So soon as the bent was finally placed in good position, and had adjusted its two legs to a firm bearing, the sway planks were unlashed, swung over, and spiked fast to the opposite corners. A third centre post was slipped down through the central sleeve to the rock, and the bent capped with a beam framed to the top of the three posts which were cut off to a horizontal line. The bent was then stay lathed to the preceeding bent, stringers were extended over, the balanced beam shoved out, and the operation repeated

Each bent thus finally consisted of three parts, thoroughly fitted to all inequalities of the surface, it was well sway braced, and sufficiently heavy of itself, to bear the thrust of the current. Had there been any danger of its slipping on the bottom, it could have been anchored fast to the rock by a churn drill working through a hole in the post, as was done on the same work in raising the posts which served as girders for the caisson for Pier No. 1, but this was not found to be necessary,

This erection of trestle work over a rock bottom proved exceedingly cheap and expeditious in practice. With adequate appliances it could be erected at the rate of 50 to 100 feet per day, in a rapid stream, flowing say 15 to 20 feet deep, and the expedients here described may afford perhaps a useful hint to other engineers in like emergencies.

According to M. Cailletet, a film of liquid carbonic acid one-twentieth af a millimetre in thickness, will prevent the passage of electricity. This liquid acid will not dissolve common salt, sodic sulphate, or calcic chloride. Potassic carbonate in it forms a bicarbonate which precipitates. Sulphur and phosphorus are insoluble in it. Iodine dissolves to a slight extent. Petroleum and ether dissolve considerable quantities of the liquid acid.

An acre is the square of the hypothenuse of a right angled triangle whose sides are, respectively, 66 ft. and 198 ft., or four rods and twelve rods.

CITY ENGINEERING IN NEW HAVEN.

The City of New Haven was organized in 1784, with a population of less than 3,000, only five miles of roads within its limits, 400 houses, and no pavement, curb, or sidewalk. The first sidewalk was laid about 60 years ago. The population is now about 60,000, the length of the streets 125 miles, with nearly 100 miles of curbs and sidewalks, and 10.973 miles of pavements, and over 7,500 dwellings.

The Board of Road Commissioners had under consideration, at *eight* of their meetings, the subject of sewer pipes; cement, vitrified both American and Scotch pipe, the hub and bevel joint, were the principal matters discussed but no decision being arrived at, a special committee was appointed by the council to consider and report upon these matters; their report does not appear in the volume under notice.

None but Telford pavements were constructed during the year 1873, and those ordered for this year are also of that description. During 1873 there were constructed 42,105 square yards of paving, at an average cost of $1.60 per square yard, the highest price being $1.836 and the lowest $1.48, and with a length of 1.966 miles. The sum total of the highest bids was $62,125.21, of the lowest $56,886.76, the difference thus being $5,238.45.

Among the various pavements, but one Belgian pavement (see *ante* p. 53), was found to need relaying. This was done at a cost of 50 cents per square yard, and $2.75 per square yard where the contractor furnished new Belgian blocks. The Telford and concrete pavements required but slight repairs during the year; the total amounts spent in repairs for three different kinds of pavement being: Belgian $4,504.95, Telford $433.53, and concrete $9.75; the total lengths of these pavements (exclusive of the 1.966 miles of new Telford pavement constructed during 1873), being Belgian 2.228 miles, Telford 4.863 miles, and concrete .491 miles.

Of other pavements, the wood pavements (total length, .558 miles,) seem to have been the most troublesome, as it is stated that they had only been laid a little over four years and yet a large amount had been expended in repairs, and thousands of dollars were still needed to put them into thorough repair; they are termed "an expensive luxury." A portion of the "Egan" pavement (of which there is .241 miles laid), is reported as being in very poor condition, but no mode of repair had been decided upon, that seeming most feasible, being to remove the top dressing of tar and asphalt and replace it with stone from the crusher, thus making it virtually a Telford pavement. The other portion of this pavement is stated to be in very good condition.

The total lengths of other kinds of pavement in use are are Macadam, .322 miles, Belgian and Telford mixed, .162 and Cobble, .142 miles.

The stone-crushing works were in active operation for eight months in the year, five men being constantly employed therein on the average, exclusive of the engineer. During this time, they crushed 9713 cubic yards of stone at an average cost (including wages, tools, &c., &c.), of about $1.39 per yard.

The steam road roller was in constant use and much demand by the contractors constructing the Telford pavements, and when not so employed was used in repairing other pavements. Its cost for coal, salaries and repairs was $1,548.55.

The total amount of grading done under contract appears to have been 36,525 cubic yards at costs varying from 55 cents down to 14 cents, the average being 28.84 cents; the highest price was caused by the length of haul being one mile for the greater part of the distance, the lowest price being for a very short haul. The total number of streets graded was 14, the length of those done by contract, 5.41 miles, and by the City, or day work 2.06 miles.

During the year, 17⅝ miles of streets were "turnpiked" with sea-shells, at a cost averaging very nearly $480 per mile.

The Joint Committee on Streets recommends that all driveways across brick walks be constructed of bricks laid edgeways, instead of the cobble stones now in use, and their estimates for a driveway 10 ft. square are: brick edgeways, with cobble gutter, 20 cents per square foot, and cobble, with cobble gutter, 14 cents.

The total length of sidewalks laid amounted to 15⅜ miles, as follows: 27,557 feet of brick wall, 27,485 ft. of concrete walk, 3,300 feet of flag walk, 11,526 feet of curbing, and 11,371 feet of brick walk relaid.

(TO BE CONTINUED.)

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